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**Acoustics—Description and
measurement of environmental
noise**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Acoustical Society of Japan (ASJ)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS Z 8731:1999** is replaced with this Standard.

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Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

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Acoustics—Description and measurement of environmental noise

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 1996-1:2016**, Edition 3, and **ISO 1996-2:2017**, Edition 3, with deletion of the methods of environmental noise description and measurement which are yet to be established in Japan, including: method of correction for difference in sound source, correction for pure sound element, impulsive element, etc., social survey on noise annoyance, and measurement uncertainties. The comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex JL.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JK. Annexes JA to JL are unique to **JIS** and not given in the corresponding International Standards.

1 Scope

This Standard defines the basic quantities to be used for the description of environmental noise and describes basic assessment procedures.

Environmental noise refers to (undesired) noise in general living environment.

NOTE 1 Annexes JA and JB provide outlines of provisions of **JIS C 1509-1** regarding frequency weightings A and C, and time weightings F and S that are used as a basis for environmental noise assessment.

NOTE 2 Annexes JC to JJ provide outlines of measuring methods for different types of noise sources that are actually used in Japan to assess environmental noise in accordance with the relevant laws and regulations such as the Noise Regulation Act and the Basic Environment Act.

NOTE 3 The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 1996-1:2016 *Acoustics—Description, measurement and assessment of environmental noise—Part 1: Basic quantities and assessment procedures*

ISO 1996-2:2017 *Acoustics—Description, measurement and assessment of environmental noise—Part 2: Determination of sound pressure levels* (Overall evaluation: MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS C 1509-1 *Electroacoustics—Sound level meters—Part 1: Specifications*

NOTE Corresponding International Standard: IEC 61672-1 *Electroacoustics—Sound level meters—Part 1: Specifications*

JIS C 1512 *Level recorders for recording sound level and/or vibration level*

JIS C 1513 *Octave-band and third-octave-band analyzers for sounds and vibrations*

JIS C 1514 *Electroacoustics—Octave-band and fractional-octave-band filters*

NOTE 1 Corresponding International Standard: IEC 61260:1995 *Electroacoustics—Octave-band and fractional-octave-band filters*

NOTE 2 The most recent edition of **IEC 61260** as of the publication of this Standard is composed of Part 1 to Part 3.

JIS C 1515 *Electroacoustics—Sound calibrators*

NOTE Corresponding International Standard: IEC 60942 *Electroacoustics—Sound calibrators*

3 Terms and definitions

For the purpose of this Standard, the following terms and definitions apply.

3.1

sound pressure, p

fluctuation of atmospheric pressure generated by sound waves in the atmosphere

NOTE Sound pressure is expressed in pascals (Pa).

3.2

A-weighted sound pressure, p_A

sound pressure value determined by use of frequency weighting A specified in **JIS C 1509-1** (see Annex JA)

NOTE 1 A-weighted sound pressure is expressed in pascals (Pa).

NOTE 2 Frequency weighting is also called frequency correction circuit.

NOTE 3 Sound pressure value determined by use of frequency weighting C (see Annex JA) is called C-weighted sound pressure.

3.3

sound pressure level, L_p

ten times the common logarithm of the ratio of the squared sound pressure effective value to the squared reference sound pressure, given by the following formula:

$$L_p = 10 \log_{10} \frac{p_e^2}{p_0^2} \dots\dots\dots (1)$$

where, p_e : sound pressure effective value (Pa)
 p_0 : reference sound pressure (20 μ Pa)

NOTE Sound pressure level is expressed in decibels (dB).

3.4

A-weighted sound pressure level, L_{pA}

ten times the common logarithm of the ratio of the squared A-weighted sound pressure effective value to the squared reference sound pressure, given by the following formula:

$$L_{pA} = 10 \log_{10} \frac{p_{Ae}^2}{p_0^2} \dots\dots\dots (2)$$

where, p_{Ae} : A-weighted sound pressure effective value (Pa)
 p_0 : reference sound pressure (20 μ Pa)

NOTE A-weighted sound pressure level is expressed in decibels (dB).

3.5

time-weighted A-weighted sound pressure level, $L_{pA,F}$, $L_{pA,S}$

A-weighted sound pressure level determined by use of time weighting F or S as specified in **JIS C 1509-1** (see Annex JB)

NOTE Time-weighted A-weighted sound pressure level is expressed in decibels (dB).

3.6

maximum A-weighted sound pressure level, $L_{pA,Fmax}$, $L_{pA,Smax}$

maximum value of time-weighted A-weighted sound pressure level

NOTE 1 Maximum A-weighted sound pressure level is expressed in decibels (dB).

NOTE 2 Maximum A-weighted sound pressure level is used for assessing single event sounds that occur within a limited duration.

3.7

N percentage exceedance A-weighted sound pressure level, $L_{AN,F,T}$

A-weighted sound pressure level determined by use of time weighting F specified in **JIS C 1509-1** that is exceeded for N % of the time interval T considered (see Figures 1 and 2)

NOTE N percentage exceedance A-weighted sound pressure level is expressed in decibels (dB).

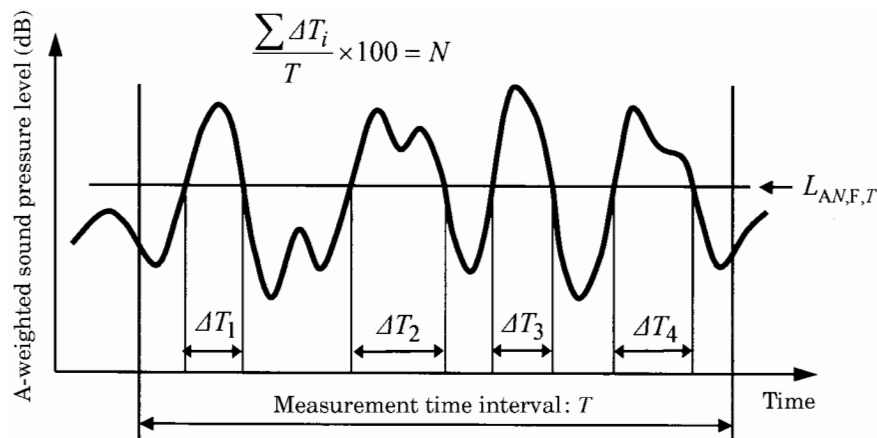


Figure 1 Chart showing N percentage exceedance A-weighted sound pressure level

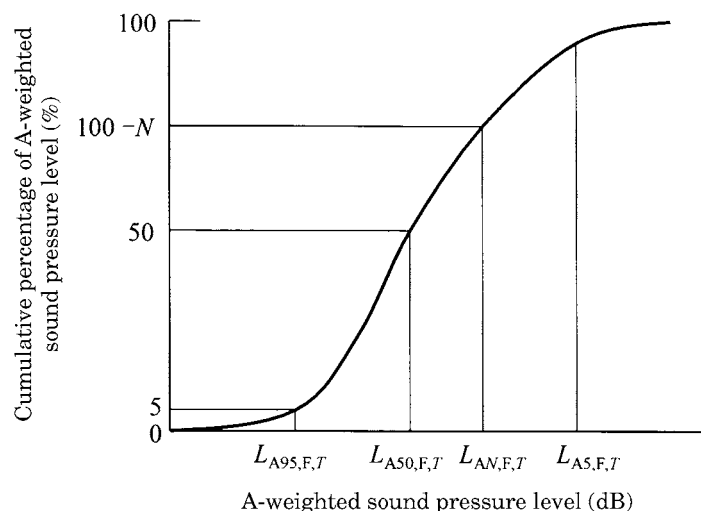


Figure 2 Curve for determining N percentage exceedance A-weighted sound pressure level

3.8

A-weighted sound exposure level, $L_{EA,T}$

quantity for evaluating the energy sum of noise (time integration value of the squared instantaneous A-weighted sound pressure) fluctuating over a stated time interval, T (starting at t_1 and ending at t_2), given by the following formula:

$$L_{EA,T} = 10 \log_{10} \frac{\frac{1}{T_0} \int_{t_1}^{t_2} p_A^2(t) dt}{p_0^2} \dots\dots\dots (3)$$

where, $p_A(t)$: instantaneous A-weighted sound pressure (Pa)

T_0 : reference time (1 s)

p_0 : reference sound pressure (20 μ Pa)

NOTE 1 A-weighted sound exposure level is expressed in decibels (dB).

NOTE 2 A-weighted sound exposure level, though rarely used by itself, is a significant assessment quantity used in the calculation process of equivalent A-weighted sound exposure level.

NOTE 3 The notation $L_{AE,T}$ may be used to express the A-weighted sound exposure level.

3.9

single event A-weighted sound exposure level, L_{EA}

quantity for evaluating the energy sum of noise (time-integration value of the squared instantaneous A-weighted sound pressure) occurring within a limited duration, given by the following formula (see Figure 3):

$$L_{EA} = 10 \log_{10} \frac{\frac{1}{T_0} \int_{t_1}^{t_2} p_A^2(t) dt}{p_0^2} \dots\dots\dots (4)$$

where, $p_A(t)$: instantaneous A-weighted sound pressure (Pa)

T_0 : reference time (1 s)

p_0 : reference sound pressure (20 μ Pa)

Unlike in Formula (3), which looks exactly the same as Formula (4), L_{EA} in Formula (4) does not depend on the integral time t_1 to t_2 as long as the noise event is included in the time interval of t_1 to t_2 . In the actual measurement, the time interval t_1 to t_2 needs to be appropriately set in order to prevent the influence of background noise (see 4.8).

NOTE 1 Single event A-weighted sound exposure level is expressed in decibels (dB).

NOTE 2 The notation L_{AE} may be used to express the single event A-weighted sound exposure level.

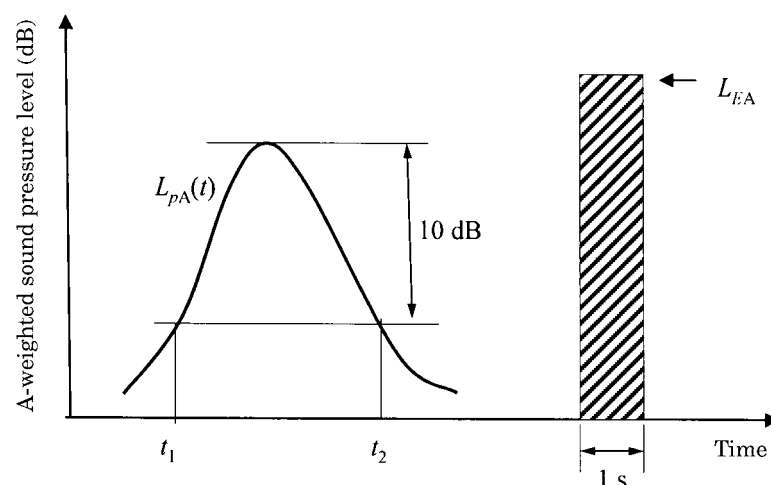


Figure 3 Single event A-weighted sound exposure level

3.10

equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$

quantity of A-weighted sound pressure level of a noise fluctuating within a stated time interval, T (starting at t_1 and ending at t_2), which is expressed as an energy average as given by the following formula (see Figure 4):

$$L_{Aeq,T} = 10 \log_{10} \frac{\frac{1}{T} \int_{t_1}^{t_2} p_A^2(t) dt}{p_0^2} \dots\dots\dots (5)$$

where, $p_A(t)$: instantaneous A-weighted sound pressure (Pa)

p_0 : reference sound pressure (20 μ Pa)

NOTE 1 Equivalent continuous A-weighted sound pressure level is expressed in decibels (dB).

NOTE 2 The subscript, T , of the notation $L_{Aeq,T}$ may be either in hours or minutes, depending on the time considered; e.g. $L_{Aeq,10min}$ in the case of 10 min and $L_{Aeq,8h}$ in the case of 8 h.

NOTE 3 The equivalent continuous A-weighted sound pressure level is also referred to as the time-average A-weighted sound pressure level.

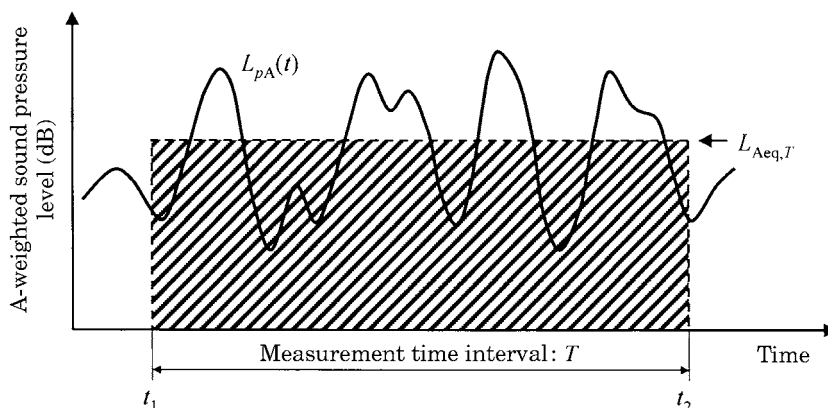


Figure 4 Equivalent continuous A-weighted sound pressure level

3.11

time-weighted equivalent continuous A-weighted sound pressure level, L_{den}

equivalent continuous A-weighted sound pressure level over one day, weighted with respect to the influence of noise during time intervals of day, evening and night, given by the following formula:

$$L_{den} = 10 \log_{10} \left[\frac{T_d}{24} 10^{L_d/10} + \frac{T_e}{24} 10^{(L_e+5)/10} + \frac{T_n}{24} 10^{(L_n+10)/10} \right] \dots\dots\dots (6)$$

where, T_d , T_e and T_n : time intervals of day, evening and night (h)

L_d , L_e and L_n : equivalent continuous A-weighted sound pressure levels during day, evening, and night (dB)

NOTE 1 Time-weighted equivalent continuous A-weighted sound pressure level is expressed in decibels (dB).

NOTE 2 The time intervals of day, evening and night depend on the type of noise source considered (see Annex JE).

3.12

reference time interval

time interval (day, night, etc.) to which an equivalent continuous A-weighted sound pressure level can be referred, determined based on typical activities of the residents of the area concerned

Where the same reference time interval is used for a long period of time, and energy average value of the equivalent continuous A-weighted sound pressure level over this period (hereafter referred to as long-term average equivalent continuous A-weighted sound pressure level) is used as a representative value of the time interval, this period is referred to as the long-term reference time interval.

3.13

observation time interval

time for which the A-weighted sound pressure level is to be measured, and during which the sound level can be expected to stay constant

The period in the observation time interval during which the sound measurement is actually performed is referred to as the measurement time interval.

3.14

total noise¹⁾

totally encompassing noise in a given situation at a given time

Note ¹⁾ One environment generally contains many different noise sources, which are classified as shown in Figure 5 for the purpose of noise assessment (see Figure 5).

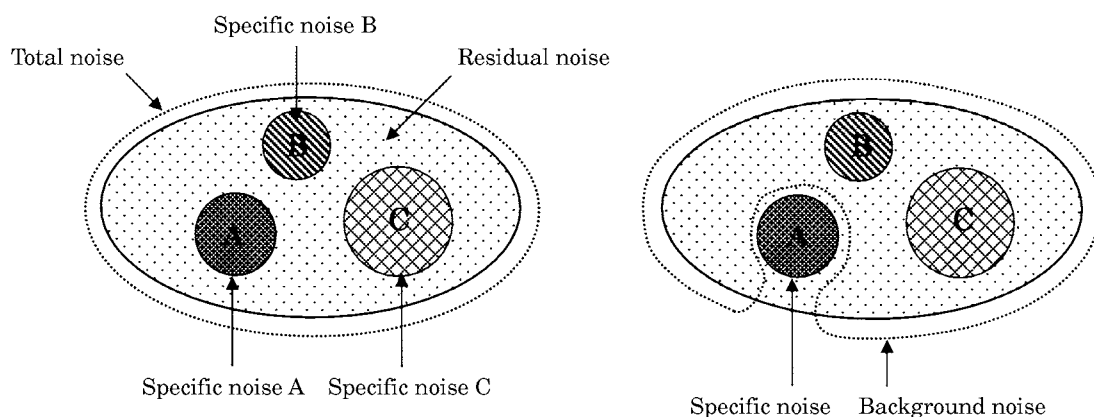


Figure 5 Composition of environmental noise

3.15

specific noise¹⁾

component of the total noise that can be specifically identified and which is associated with a specific source

3.16

residual noise¹⁾

total noise when all the specific noises are suppressed

3.17

background noise¹⁾

all noises other than the one specific noise to be considered

3.18

stationary noise²⁾

noise whose change of level is small and, therefore, is considered to be approximately stable

Note ²⁾ The noise sources are classified as shown in Figure 6 according to time fluctuation characteristics.

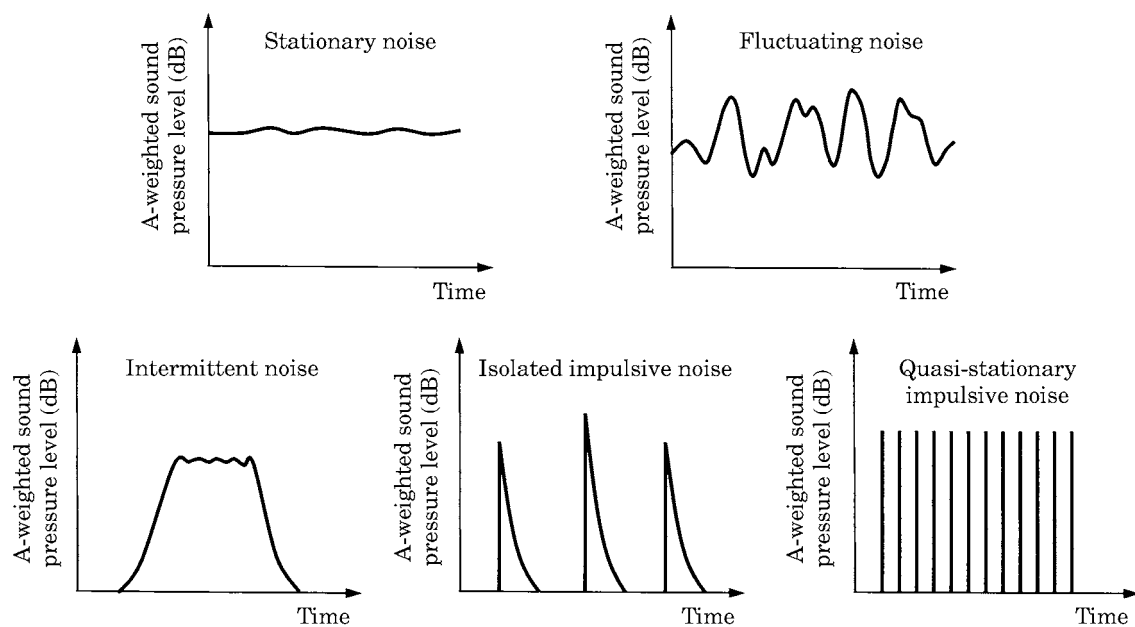


Figure 6 Classification of noises according to time fluctuation characteristics

3.19

fluctuating noise²⁾

continuous noise whose sound pressure level varies significantly, but not in an impulsive manner, during the observation period

3.20

intermittent noise²⁾

noise that occur at regular or irregular time intervals and is such that the duration of each such occurrence is several seconds or more

3.21

impulsive noise²⁾

noise characterized by very brief bursts of sound pressure

NOTE Impulsive noise may be classified into isolated impulsive noise where individual noise events are separable and discrete, and quasi-stationary impulsive noise where noise events occur continuously and at approximately constant and very short intervals.

4 Measurement

4.1 General

General matters of environmental noise measurements are provided in the following.

4.2 Measuring instruments

The following measuring instruments shall be used.

a) **Sound level meter**, specified in **JIS C 1509-1**.

A windscreen shall always be used to reduce the influence of wind noise produced by wind blowing against the microphone; this is especially important for low-level noise measurements that are more significantly influenced by wind noise. An all-weather windscreen is desirable that can also prevent impact by noise produced by precipitation.

b) **Sound calibrator**, of the type specified in the instruction manual or other similar document, conforming to Class 1 or Class LS specified in **JIS C 1515**, to be used for acoustically checking the operation of a sound level meter including the microphone.

It shall have been calibrated at intervals not exceeding three years. A measurement manual etc. should be consulted for specific instructions for measurement of different types of noise sources.

c) **Level recorder**, specified in **JIS C 1512**. A measurement manual etc. should be consulted for specific instructions for measurement of different types of noise sources.

d) **Recording device**, having the frequency range and dynamic range as specified in **JIS C 1509-1** if used for recording the sound pressure signals at the site for later analyses. It shall not have a signal compression function.

e) **Frequency analyzer**, of Class 1 specified in **JIS C 1513**, or a filter of Class 1 specified in **JIS C 1514** if octave- or third-octave-band analysis is performed.

4.3 Measurement position

The selection of measurement position shall be as follows.

- a) **Outdoor measurements** When it is desired to minimize the influence of reflections then measurements should, whenever possible, be carried out at least 3.5 m from any reflecting structure other than the ground. The measurement height is to be chosen appropriately for the specific objective of the measurement, but unless otherwise specified, the preferred height is 1.2 m to 1.5 m above the ground.
- b) **Outdoor measurements near buildings** For the measurements at places where noise to which a building is exposed is of interest, if not otherwise specified, the preferred measurement positions are 1 m to 2 m from the affected façade of the building under assessment and 1.2 m to 1.5 m above the floor.
- c) **Measurements inside buildings** If not otherwise specified, the preferred measurement positions are at least 1 m from the walls or other reflecting surfaces, about 1.5 m from affected windows or other openings and 1.2 m to 1.5 m above the floor. Normally, this measurement is not part of a general environmental monitoring.

4.4 Meteorological conditions

Sound levels are affected by meteorological conditions, especially when the transmission distance is large. Where levels are likely to be affected by meteorological conditions they should be measured in one of the two ways described below.

- a) **Measurements made under a range of meteorological conditions** The observation time intervals are chosen in such a way that the long-term average A-weighted sound pressure level is determined over the range of meteorological conditions found at the measurement position.
- b) **Measurements made under specific meteorological conditions** The observation time intervals are chosen so that measurements are taken only under carefully specified meteorological conditions. Normally, the conditions chosen will be those which result in the most stable sound propagation, that is, wind velocity vector has a significant positive wind component from source to measurement position (favourable propagation).

4.5 Measurement of stationary noise

Stationary noise measurements shall be performed as follows.

- a) When the A-weighted sound pressure level is stable, use the time weighting S of the sound level meter. If it is found to fluctuate, use the integral average function of the sound level meter to obtain an equivalent continuous A-weighted sound pressure level over a given time.
- b) The background noise when measuring a specific stationary noise may be considered negligible if the difference in reading between measurements with and without the noise of interest is 10 dB or more; if it is less than 10 dB, its influence should be considered.
- c) In the latter case, the A-weighted sound pressure level of the noise of interest without the background noise can be estimated by correcting the measured value with the noise of interest using the values in Table 1. It is necessary that the background noise level is stable. This correction may result in a large error if performed when the difference in reading between measurements with and without the noise of interest is 3 dB or less.

Table 1 Correction of sound level meter readings for influence of background noise

	Unit: dB					
Difference in reading between measurements with and without the noise of interest	4	5	6	7	8	9
Correction value	-2		-1			

4.6 Measurement of maximum A-weighted sound pressure level

For the maximum A-weighted sound pressure level by the time weighting F or the time weighting S of a single-event noise such as impulsive noise and intermittent noise, set the time weighting of the sound level meter to F or S, respectively, and obtain the maximum by sampling the A-weighted sound pressure level at a time interval of 100 ms or less. Indicate in the measurement result which of the time weightings was used for measurement.

4.7 Measurement of *N* percentage exceedance A-weighted sound pressure level

For measuring *N* percentage exceedance A-weighted sound pressure level of a fluctuating noise, read the A-weighted sound pressure level at a sampling time interval of 100 ms or less using the time weighting F of the sound level meter, obtain the cumulative frequency curve and read the *N* percentage value from the result (see Figure 2).

4.8 Calculation of single event A-weighted sound exposure level

The single event A-weighted sound exposure level, L_{EA} , shall be obtained by Formula (4) of 3.9. Although L_{EA} does not depend on t_1 and t_2 as long as the noise event is included in the integral time of t_1 to t_2 , presence of a large background noise can cause an error by being included in the integration (see 3.9). Even when, to prevent this error, the integration is performed from when the A-weighted sound pressure level reaches its maximum point to when it is 10 dB lower than the maximum value, the deviation from a true value is negligibly small (see Figure 3).

4.9 Calculation of equivalent continuous A-weighted sound pressure level

The equivalent continuous A-weighted sound pressure level shall be determined according to either of the methods described below based on the time fluctuation characteristics of noise.

- a) **Fluctuating noise** Obtain the equivalent continuous A-weighted sound pressure level using the integral average function of a sound level meter over the whole measurement time interval that has been set. When measuring over a long time, time-sampling method may be used. For example, divide the reference time interval into observation time intervals of 1 h and measure the equivalent continuous A-weighted sound pressure level during a fixed measurement time interval of 10 min or more in each observation time interval. Energy-average the measured results according to Formula (7) and take the averaged result as the equivalent continuous A-weighted sound pressure level of the reference time interval.

$$L_{Aeq,T} = 10 \log_{10} \left[\frac{1}{N} \sum_{i=1}^N 10^{L_{Aeq,Ts,i}/10} \right] \dots\dots\dots (7)$$

where, $L_{Aeq,Ts,i}$: equivalent continuous A-weighted sound pressure level during i th ($i=1$ to N) measurement time interval (T_s) (dB)

N : total number of measurements performed for each reference time interval

- b) **Intermittent noise** To determine the equivalent continuous A-weighted sound pressure level of a specific intermittent noise during the reference time interval, calculate it according to Formula (8) using the measured result of single event A-weighted sound exposure level of every noise event.

$$L_{Aeq,T} = 10 \log_{10} \left[\frac{T_0}{T} \sum_{i=1}^N 10^{L_{EA,i}/10} \right] \dots\dots\dots (8)$$

where, $L_{EA,i}$: i th ($i=1$ to N) single event A-weighted sound exposure level (dB)

N : total number of measurements of single event A-weighted sound exposure level

T : duration of reference time interval (s)

T_0 : reference time (1 s)

5 Information to be recorded

Together with the noise measurement results, the record containing the following information shall be stored for future reference.

a) Date and time of measurement

- 1) Date and time of measurement
- 2) Other specifics of measurement, including reference time interval, observation time interval, and measurement time interval

b) Measurement method

- 1) Instrumentation and measurement method used, and method of calculation if used
- 2) Measurement position (position and height)

c) Measuring conditions

- 1) Atmospheric condition: wind direction, wind speed, presence of precipitation, and temperature, barometric pressure and relative humidity at the ground level or other height
- 2) Type and condition of ground between sound source and measurement position